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Enhancement of cryogenic distillation by the presence of a gradient magnetic field

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The demands for industrial gases are increasing rapidly. It is of great importance to further reduce the energy consumption and cut down the unit cost for gases, in particular for the large-scale air separation systems, which mainly depends on cryogenic distillation. However, since the air separation device itself technical limitations, it is challenging to significantly improve the efficiency of cryogenic distillation. Oxygen has a relatively high magnetic susceptibility compared to other gases and displays a paramagnetic behavior. The unique property can be employed to enrich oxygen from atmospheric air by introducing magnetic field, but still hard to obtain a high efficiency at room temperature. Fortunately, the magnetic susceptibility of oxygen rises dramatically at low temperatures. We propose a novel method to realize an efficient combination of distillation and magnetic separation at cryogenic temperatures to enhance separation efficiency. In order to verify the principle, liquid flow and particle diffusion under high gradient magnetic field were investigated numerically for a wide range of magnetic flux density gradient and a series of magnetic structure. The magnetic effect on liquid oxygen-nitrogen mixture was also investigated experimentally using a laser interferometer. The concentration gradient was formed around the edge of magnetic structure. The facts demonstrate the possibility to improve the efficiency of cryogenic distillation by applying a high gradient magnetic field.

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